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EFFECT OF SMALL MAGNETIC STORMS ON THE DIURNAL VARIATION OF THE NEUTRON COMPONENT OF COSMIC RAYS

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EFFECT OF SMALL MAGNETIC STORMS ON THE DIURNAL VARIATION OF THE NEUTRON COMPONENT OF COSMIC RAYS

N. Akhababyan and T. Gruyeva

ABSTRACT. Continuous recordings of the neutron component of cosmic rays were made at the top of Mt. Musal from September, 1964 to September, 1965. The amplitude of the first harmonic of the diurnal variation of the neutron component for days with magnetic storms is always greater than on magnetically quiet days. The second harmonic shows no such relationship.

The diurnal variations of cosmic rays which have been observed are the /1895* result of a complex superposition of such phenomena as meteorological effects, asymmetry of the geomagnetic field, anisotropy caused by the action of cosmic rays of solar origin, etc. It is therefore interesting to study the effect of each of these factors on the course of the diurnal variation of the various components of cosmic radiation.

In their analysis of data from μ-meson telescopes, Jagi and Ueno [1] concluded that the amplitude of the diurnal variation in time of magnetic storms increases and the time of their maximum occurs earlier than on magnetically quiet days. A similar effect was noted by A. I. Kuzmin' and G. V. Sripin [2] for the general ionizing component at sea level and for μ-mesons at a depth of 60 m. The effect of geomagnetic storms on the intensity of the neutron component was studied by Sekido and Yoshida [3]. The period examined by them is characterized by powerful magnetic storms, accompanied by Forbush effects with an amplitude of about 10%. An increase of the amplitude of the diurnal variation by a factor of 2 was noted in these cases.

The present paper deals with a study of the effect of small magnetic storms on the course of the diurnal variation of the neutron component of cosmic radiation.

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*Numbers in the margin indicate pagination in the foreign text.

We used data from continuous recordings of the neutron component of cosmic rays, made at the top of Mt. Musal (λ = 25°35'E, ϕ = 42°11'N, height = = 2,925 m above sea level) with the aid of a standard Simpson-type neutron monitor [4]. The latter consists of two identical units for local generation of neutrons, with 6 type SNM-8 counters in each. Each unit is equipped with its own independent electronic amplifier, recording and power-supply system, so that the two units can be used to check one another. The average recording intensity of approximately 10^5 impulses/hr^{-1} provides sufficiently high statistical accuracy to allow investigation of a number of astrophysical problems of cosmic-ray physics.

During the period from September, 1964 to September, 1965 we recorded 23 small magnetic storms, accompanied by clearly pronounced Forbush effects with an amplitude of approximately 1% [5]. Small magnetic storms are characterized by δD = 100 - 139', δH = 80 - 125γ, δZ = 40 - 90γ; the data on magnetic storms were taken from monthly surveys [6]. For purposes of comparison, the entire interval was divided into four equal subperiods and each of the latter was analyzed separately as follows: In each such subperiod, those days were picked out on which small magnetic storms were observed, and the magnetically-quiet days were likewise selected. After the data have been sorted, if we then calculate the average K_p index for these two groups, we find that K_p = 23.3 for days with magnetic storms and K_p = 16.8 for magnetically quiet days.

The amplitudes and phases of the first and second harmonics of the Fourier expansion of the diurnal variation for data that were either corrected /1896 or uncorrected for the barometric effect were calculated for each such group. Then, in accordance with our earlier work [7], in which we demonstrated the existence of a noticeable temperature effect in the neutron component and its effect on the diurnal variation [8], these data were corrected with the aid of coefficients obtained and used in the same paper [8]. The amplitudes and phases of the first and second harmonics of diurnal variation were again calculated for the data that had been calculated in this manner.

Tables 1, 2 and 3 list the amplitudes and phases of the first harmonic for uncorrected data (A_1, t_1), data corrected for the barometric effect (A_{1p}, t_{1p}), and data corrected for both barometric and temperature effects (A_{1pT}, t_{1pT}) for all four subperiods of the interval in question, both for days with magnetic storms and for magnetically quiet days.

TABLE 1.

Periods	A_1, %		t_1, hours, U.T.	
	Days with magnetic storms	Magnetically quiet days	Days with magnetic storms	Magnetically quiet days
I	0,45±0,03	0,20±0,02	$12^h15^m\pm10^m$	$10^h25^m\pm10^m$
II	0,54±0,04	0,20±0,03	12 50±10	14 00 ±10
III	0,47±0,03	0,31±0,02	13 05±10	13 35 ±10
IV	0,41±0,02	0,23±0,02	16 50±10	14 40 ±10
Σ	0,36±0,01	0,22±0,01	15 35±0,5	15 05 ±0,5

TABLE 2.

Periods	A_{1p}, %		t_{1p}, hours, U.T.	
	Days with magnetic storms	Magnetically quiet days	Days with magnetic storms	Magnetically quiet days
I	0,32±0,03	0,12±0,02	$13^h20\pm10^m$	$12^h20^m\pm10^m$
II	0,33±0,04	0,16±0,03	16 15±10	16 00 ±10
III	0,24±0,03	0,15±0,02	15 05±10	12 10 ±10
IV	0,19±0,02	0,13±0,02	12 25±10	10 45 ±10
Σ	0,24±0,01	0,12±0,01	15 10±0,5	14 15 ±0,5

TABLE 3.

Periods	A_{1pT}, %		t_{1pT}, hours, U.T.	
I	0,66±0,03	0,39±0,03	$15^h15^m\pm10^m$	$13^h10^m\pm10^m$
II	0,60±0,04	0,35±0,04	16 20±10	14 15 ±10
III	0,43±0,03	0,32±0,03	14 15±10	13 10 ±10
IV	0,42±0,02	0,34±0,02	13 05±10	12 40 ±10
Σ	0,56±0,01	0,42±0,01	14 10±0,5	13 05 ±0,5

Tr. Note: Commas indicate decimal points.

Obviously, regardless of the magnitude of the meteorological corrections, the amplitude of the first harmonic of the diurnal variation of the neutron component for days with magnetic storms is always greater than the amplitude of this variation on magnetically quiet days. The phases on magnetically active days occur approximately one hour later than on magnetically active days. Since the dependence of the amplitude and phase upon magnetic activity of the Earth have a unique character in the four subperiods, we have compared

the entire period under consideration. The amplitudes and phases obtained are listed in the last columns of Tables 1-3, from which it is possible to observe the tendency mentioned above. The relative change in amplitude as a function of the meteorological corrections employed agree with the results in [8]. /1897

Tables 4 and 5 list the amplitudes and phases of the second harmonics of the diurnal variation for days with magnetic storms (Table 4) and for magnetically quiet days (Table 5). There is no dependence of the second harmonics of diurnal variation of the neutron component on small magnetic storms or on meteorological corrections within the limits of statistical error.

TABLE 4.

Periods	A_2, %	A_{2p}, %	A_{2pT}, %	t_{2p}, hours U.T.	t_{2pT}, hours U.T.	t_2, hours, U.T.
I	0,15±0,03	0,10±0,03	0,13±0,03	16^h10^m	15^h05^m	11^h30^m
II	0,14±0,03	0,13±0,03	0,14±0,03	12 15	11 10	11 45
III	0,17±0,03	0,15±0,03	0,16±0,03	15 20	15 00	13 45
IV	0,13±0,02	0,15±0,02	0,14±0,02	11 05	14 10	14 40
Σ	0,13±0,02	0,11±0,02	0,12±0,02	15 05	13 10	13 40

TABLE 5.

Periods	A_2, %	A_{2p}, %	A_{2pT}, %	t_{2p}, hours U.T.	t_{2pT}, hours U.T.	t_2, hours U.T.
I	0,16±0,03	0,14±0,03	0,15±0,03	16^h40^m	16^h10^m	15^h55^m
II	0,16±0,03	0,14±0,03	0,16±0,03	15 30	12 40	11 15
III	0,15±0,03	0,12±0,03	0,14±0,03	15 20	11 30	14 10
IV	0,14±0,02	0,11±0,02	0,12±0,02	15 05	13 40	14 10
Σ	0,14±0,02	0,12±0,02	0,13±0,02	15 15	13 10	14 50

Tr. Note: Commas indicate decimal points.

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